Analyzing U.S. Wheat Acreage Response Under the 1996 Farm Act

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Abstract: This article presents results for wheat from a recent study on supply response. The own-price supply elasticity is estimated at 0.36 for all U.S. wheat—0.38 for winter wheat and 0.29 for spring wheat—little changed from 1986-90. The cross-price elasticities, in most cases, show larger changes under the 1996 Act. A lower wheat price expected by producers, especially for soft red winter (SRW) wheat, is the most significant factor contributing to the 7-percent decline in 1999 winter wheat seedings. Lower expected prices for durum and other spring wheats are expected to lower planting intentions from last year for these crops.

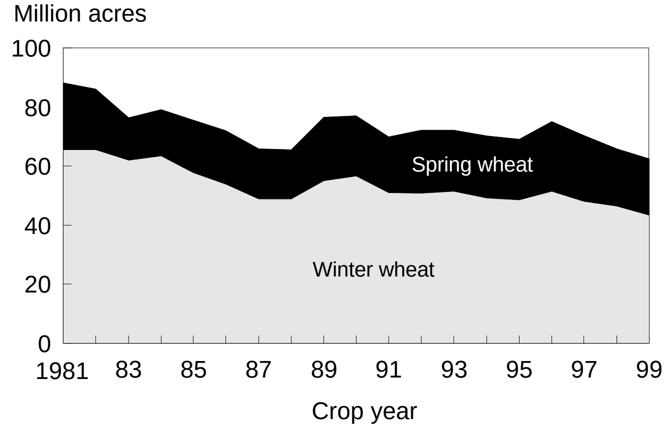
Keywords: Acreage response, acreage price elasticities, wheat, winter wheat, spring wheat

U.S. wheat planted acreage has shown a declining trend since 1981 when it hit a record high of 88.3 million acres (fig. A-1). Until the enactment of the 1996 Farm Act, year-to-year variations in acreage were affected by not only costs and returns of growing wheat relative to competing crops, but also provisions of wheat programs, such as deficiency payments, annual set-aside and acreage reduction programs, paid land diversions, and the Conservation Reserve Program (CRP). However, since 1996 for spring wheat and 1997 for winter wheat, farmers have based their planting decisions primarily on market forces—expected farm prices and net returns of wheat relative to competing crops. The 1996 Farm Act decoupled program payments from planting decisions and removed concerns over base acreage protection, making fundamental changes towards full planting flexibility.

Since the enactment of the 1996 Farm Act, wheat planted acreage has declined 3 years in a row—down from 75.1 million acres in 1996 to 70.4 million in 1997, 65.9 million in 1998, and a projected 62.5 million in 1999 (Riley). The decline applies to both winter and spring wheats. Planted acreage for 1999 winter wheat was estimated in January by USDA at 43.4 million acres, down 3 million from last year and 8 million below 1996 (USDA, 1999). The acreage for 1999 spring wheat (including durum) was projected at 19.1 million in late February, down slightly from last year but well below the 23.7 million in 1996 (Riley).

It is not totally surprising to see the rapid decline in wheat acreage since 1996. Given nearly full planting flexibility, wheat farmers were offered incentives to switch away from wheat to other more profitable crops, such as corn, soybeans, and minor oilseeds (sunflower, canola, or rapeseed).

Figure A-1
Winter and Spring Wheat Planted Acreage



1999 USDA projections, Agricultural Outlook Forum, February 23, 1999.
Source: Economic Research Service, USDA.

For example, based on the ERS Agricultural Resource Management Survey (ARMS), while wheat producers in the Central and Southern Plains region had an average net return of $34.8 per acre in 1997, corn producers averaged a net return of $135.6 per acre in the Plains States. The average net return for soybeans was even higher—$166.2 per acre in the Northern Plains.[2] Thus, wheat acreage in the Central and Northern Plains region has declined in recent years and acreage planted to corn and soybeans has increased.

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[2] The comparison of average net returns among these crops may not be all based on comparable land due to differences in the regional breakdown for these crops in ARMS. Also, even in the same area, producers can switch from wheat to soybeans only on farms where precipitation is adequate for soybean production.

Estimating Supply Response

The limited time since the passage of the 1996 Act complicates the study of producers' acreage response. To increase the number of observations, State-level information on producers' planting decisions during 1991-95, when producers were granted limited planting flexibility under the 1990 Farm Act, was used. The time series (1991-95) and cross section (State) data were pooled to enhance the degree of freedom. This study focuses on producers participating in 1991-95 wheat programs.

The approach adopted in this study assumes that wheat producers maximize their expected net returns. Wheat producers' acreage response is estimated on normal flex acreage (NFA), which represents the majority of producers who made planting decisions, at the margin, within the range of NFA.[3] The results are then extended to the whole farm and included acreage impacts on both NFA and the rest of base.

Wheat supply response is estimated for major production regions, including the Central and Northern Plains, Southern Plains, North Central, and Southeast and Delta regions combined (fig. A-2). Acreage price elasticities are approximated from the estimates developed in a Food and Agricultural Policy Research Institute (FAPRI) study for the Northeast and Far West regions based on the relationship between ERS and FAPRI estimates for neighboring regions.

Supply response on wheat NFA is estimated by pooling time-series (1991-95) with cross-section (State) data in each production region. The acreage response is specified in two models, where the dependent variable is specified differently. In Model 1, a lower-bound estimate, the dependent variable is specified as the percent of wheat NFA planted to wheat or alternative crops. In Model 2, an upper-bound estimate, the percent of the combined NFA and acreage reduction program (ARP) acreage planted to wheat or alternative crops is used as an alternative dependent variable to derive estimates (Westcott).[4]

[3] NFA refers to 15 percent of base acres where farmers were allowed to grow the base crop, other program crops, soybeans and other oilseeds, any other approved non-program crops, or leave the cropland idle without loss of base acreage, but received no deficiency payments.

[4] Specifying the dependent variable in the acreage response equation as the percent of wheat NFA planted to wheat may result in some measurement problems relative to the underlying acreage shifts. This results from changes in the acres covered by NFA for different ARP levels across years. These measurement problems introduce a downward bias into the estimated own-price coefficient resulting from interaction of NFA acreage with the year-specific ARP that reflects an inverse relationship between the expected price and the ARP level. That is, the acreage response reflects the effect of a change not only in the expected price, but also in ARP. A possible adjustment to the dependent variable to address this concern is to incorporate the ARP into the dependent variable. One way to do this is to define the dependent variable as the percent of the combined NFA plus ARP land that was planted to the base crop or alternatives. This alternative reduces the measurement's downward bias, but it does not fully eliminate it. However, it also adds a policy-related upper bias to the measurement of acreage shifts.

Explanatory variables in both Models 1 and 2 include expected net returns for the program crop itself (wheat in this case) and competing crops, as well as a set of intercept dummies for States in the region. Expected net returns equal the expected price times the trend yield by State minus variable cash costs of production for the region. The expected price is the new-crop futures price at harvesttime in the month when planting decisions are made by producers. The new-crop futures price for winter wheat, spring wheat, and competing crops has the following time dimensions:

Hard red winter (HRW) wheat: July futures price at the Kansas City Board of Trade in mid-October, previous year.

Soft red winter (SRW) wheat: July futures price at the Chicago Board of Trade in mid-October, previous year.

Spring wheat: September futures price at the Minneapolis Grain Exchange in mid-May, current year.

Corn: December futures price at the Chicago Board of Trade for the Midwest region and September futures price for the South, as observed in mid-October, previous year, for winter wheat and mid-March, current year, for spring wheat.

Soybeans: November futures price at the Chicago Board of Trade in mid-October, previous year, for winter wheat and mid-March, current year, for spring wheat.

Cotton: December futures price at the Chicago Board of Trade in mid-October, previous year.

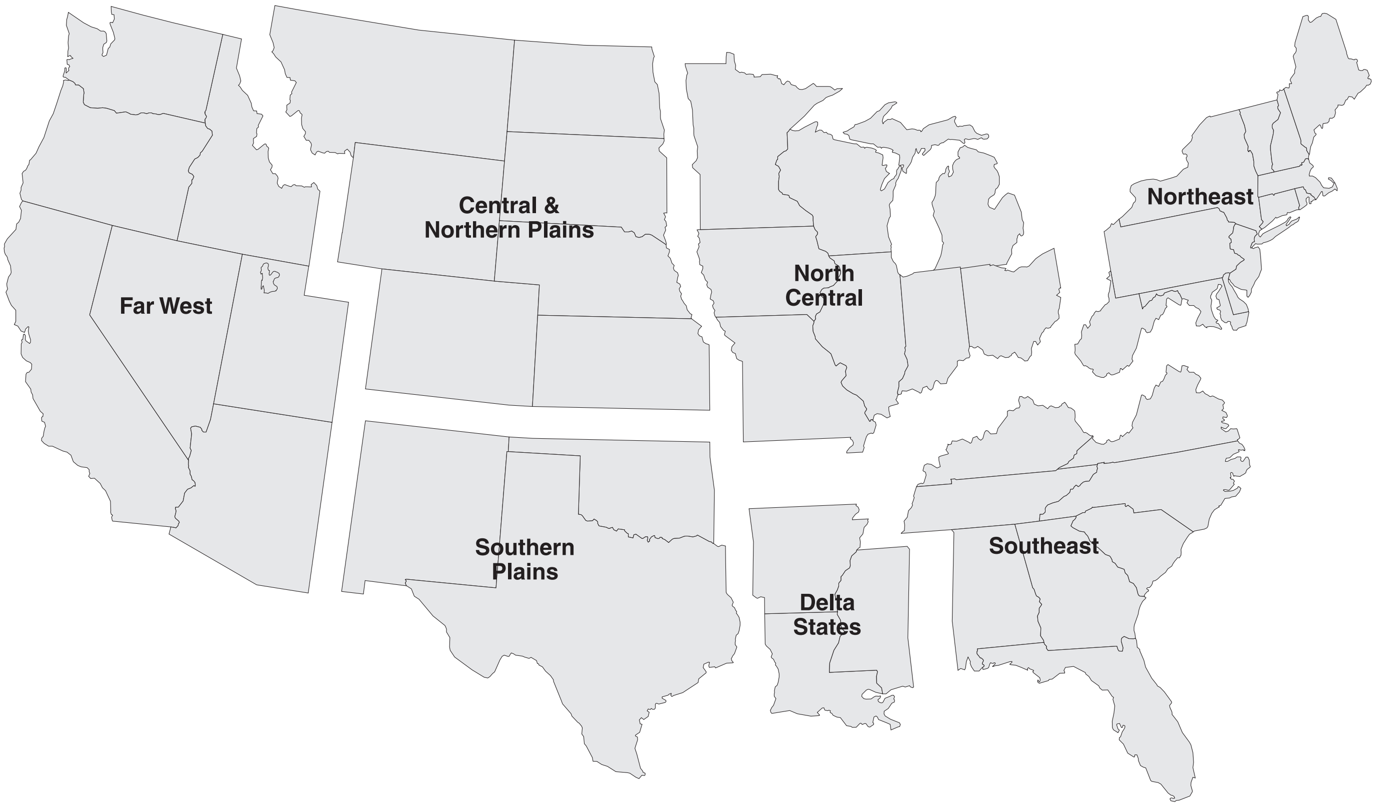
The new-crop futures price is further adjusted by the expected basis (the difference between futures prices and cash prices received by farmers in the month right before the delivery month of the futures) to allow for price differentials across States, and to arrive at the farm-price equivalent. The trend yield is estimated using State data for 1975-95.

The acreage response equations in terms of wheat NFA planted to wheat, other program crops, soybeans, minor oilseeds, other crops, and NFA idled are estimated by Seemingly Unrelated Regression (SUR) as a system (Zellner).[5] In addition, to the extent that it is appropriate, theoretical constraints—symmetry and linear homogeneity—are imposed in the SUR estimation procedures.[6]

[5] Due to the small sample size, any gain in efficiency of the estimation by SUR, relative to ordinary least squares (OLS), is limited. Thus, in many cases, there are only very small changes in the regression coefficient, although t-ratios are increased in some cases.

[6] The symmetry restriction requires that cross-net return regression coefficients across the share equations be equal while the linear homogeneity constraint requires that the sum of all own- and cross-return regression coefficients in each of the equations be zero. The symmetry restriction reflects the notion that the cross-price elasticities are linked to the ratio of the acreage shares between two competing crops. The linear homogeneity constraint reflects the fact that the share of wheat NFA is homogenous of degree zero in prices since the same proportional change in net returns for the program crop and competing crops does not alter the share of wheat NFA planted to a specific crop.

Figure A-2
U.S. Crop Production Regions



Estimated Acreage Price Elasticities

Acreage price elasticities for all wheat in the major production regions are derived, in part, from regression coefficients in the estimated acreage response equations on NFA (table A-1). Acreage response on NFA associated with a 1-percent change in the expected price is first estimated, and then extended to the rest of base acreage. Thus, acreage price elasticities reported in this study reflect the whole farm acreage response, not just the response on NFA. Also, the midpoint average of the acreage price elasticities from Model 1 and Model 2 is used as the "best estimate."

The own-price supply elasticity of U.S. wheat is estimated at 0.36 under the 1996 Act, little changed from the 0.34 for 1986-90, when producers were only allowed limited planting flexibility (table A-2).[7] This lack of increase in the elasticity for U.S. wheat is partially explained by the fact that much of U.S. wheat is produced in the Great Plains where producers have few alternatives to growing wheat. The elasticity in the Central and Northern Plains was estimated at 0.20 during 1986-90, compared with the 0.24 estimated under the 1996 Act.

[7] The own-price elasticity refers to the percentage change in wheat acreage in response to a 1-percent change in the expected wheat price. Acreage price elasticities during 1986-90 are those estimated by FAPRI (Adams).

Most cross-price elasticities estimated under the 1996 Act also show an increase from 1986-90. At the national level, barley and sorghum are the two primary competing crops for wheat land. For example, a cross-price elasticity of-0.092 with respect to barley price means that a 1-percent increase in the expected barley price would cause a 0.092-percent decline in U.S. wheat planted acreage. Corn, cotton, and oats are also important competing crops in some areas. The effect of a 1-percent change in the expected soybean price on wheat acreage is the smallest among the competing crops. This is due to the fact that the negative effect on wheat plantings of increasing soybean prices in most regions is partially offset by a positive effect in the Southeast and Delta regions, where double cropping of winter wheat and soybeans is more common.

The own-price elasticity of winter wheat plantings is estimated at 0.38 under the 1996 Act, considerably higher than 0.29 for U.S. spring wheat (table A-3). A larger number of competing crops and a wider geographic distribution of winter wheat production make winter wheat acreage more responsive to changes in its price.

Sorghum is the primary competing crop for winter wheat. However, barley is the dominant competing crop for spring wheat. The cross-price elasticity of-0.087 with respect to the

Table A-1--Estimated regression coefficients in wheat acreage response on NFA by production region

Region	Explanatory variable	Model 1 1/ (lower bound)	Model 2 1/ (upper bound)
Central and Northern Plains	Wheat net returns	0.147	0.359
		(2.29)	(1.90)
	Soybean net returns	-0.028	-0.005
		(-0.90)	(-0.17)
	Barley net returns	-0.146	n.a.
		(-2.90)	
	Sorghum net returns	n.a.	-0.354
			(-1.86)
Southern Plains	Wheat net returns	0.632	0.749
		(5.32)	(6.37)
	Cotton net returns	-0.060	-0.062
		(-2.18)	(-2.02)
	Corn net returns	-0.072	-0.095
		(-2.44)	(-1.49)
	Sorghum net returns	-0.150	-0.431
		(-1.32)	(-1.84)
North Central	Wheat net returns	0.095	0.169
		(1.65)	(4.43)
	Corn net returns	-0.007	-0.120
		(-0.40)	(-6.63)
	Soybean net returns	-0.019	-0.049
		(-0.65)	(-0.96)
	Oat net returns	-0.418	n.a.
		(-5.00)	
Delta and Southeast	Wheat net returns	0.226	0.369
		(4.03)	(7.28)
	Soybean net returns	0.265	0.417
		(4.65)	(4.28)
	Corn net returns	-0.122	-0.199
		(-2.77)	(-2.72)
	Sorghum net returns	-0.100	-0.161
		(-1.70)	(-2.69)

n.a.= Not applicable. 1/ Figures in parentheses are t-ratios.

sorghum price in winter wheat plantings means that a 1-percent increase in the expected sorghum price would cause a 0.087-percent decline in winter wheat plantings (table A-3). The effect of a 1-percent change in barley price on spring wheat plantings is greater, with a cross-price elasticity of -0.100. This is because barley production is concentrated in the spring wheat growing area. Minor oilseeds, such as sunflower and canola, also compete with spring wheat.

Supply elasticities for all wheat plantings vary among major production regions. The wheat own-price elasticity in the Central and Northern Plains region (0.240) is the lowest, while that for the North Central region (0.567) is the highest (table A-4).[8] In the Central and Northern Plains, where about 55 percent of U.S. wheat is grown, the own-price elasticity under the 1996 Act is about 20 percent higher than during 1986-90. Among major production regions, the North Central has the least increase in the own-price elasticity—only 2.5 percent. Barley and sorghum are the two primary competing crops for all wheat in the Central and Northern Plains region.[9] The increase in the cross-price elasticity with respect to soybean prices reaches 100 percent, reflecting higher profitability of growing soybeans on farms where precipitation is adequate for soybean production.

Table A-2--Acreage price elasticities for U.S. wheat under the 1996 Act vs. previous legislation

Variable	1986-90 (1)	1996 Act (2)	Difference (3)
Wheat price	0.336	0.355	0.019
Barley price	-0.080	-0.092	0.012
Sorghum price	-0.058	-0.080	0.022
Corn price	-0.030	-0.037	0.007
Soybean price	-0.002	-0.010	0.008
Cotton price	-0.028	-0.023	-0.005
Oat price	n.a.	-0.011	n.a.

n.a. = Not applicable.

Table A-3--Acreage price elasticities for U.S. winter wheat and spring wheat under the 1996 Act

Variable	Winter wheat	Spring wheat
Wheat price	0.383	0.291
Sorghum price	-0.087	n.a.
Barley price	n.a.	-0.100
Corn price	-0.016	-0.016
Soybean price	-0.004	-0.004
Cotton price	-0.033	n.a.
Oat price	-0.011	-0.011

n.a. = Not applicable.

While virtually all cross-price elasticities have a negative sign, the cross-price elasticity of wheat acreage with respect to the soybean price in the Southeast and Delta has a positive sign because soybean-wheat double cropping is common in that region (table A-4). For example, the percentage of 1998 acreage planted to soybeans following another crop (primarily wheat) was estimated at 42 percent in Georgia, 51 percent in Kentucky, and 44 percent in North Carolina (USDA, 1998).[10] The cross-price elasticity of 0.164 with respect to the soybean price in this region means that wheat plantings in the Southeast and Delta would increase 0.164 percent, instead of decline as in other regions, if there is a 1-percent increase in the expected price of soybeans. This also is why the corn cross-price elasticity is the greatest negative.

[8] Acreage price elasticities in the Southern Plains and Delta and Southeast regions were estimated by Scott Sanford and Bob Skinner of the Economic Research Service, USDA, at the time of this study.

[9] In this region, barley primarily competes with spring wheat and sorghum competes with winter wheat. In fact, in many areas of the Northern Plains, spring wheat is a primary competing crop for winter wheat.

[10] These percentages did not deviate greatly from those in 1996 when winter wheat acres were the highest in recent years—50 percent in Georgia, 45 percent in Kentucky, and 40 percent in North Carolina.

Table A-4--Acreage price elasticities for wheat in major production regions under the 1996 Act vs. previous legislation

Variable	1986-90 1/	1996 Act 2/	Percent difference (in absolute value)
	(1)	(2)	(3)=(((2) - (1))/(1))*100
		Central and Northern Plains	
Wheat price	0.201	0.240	+19.4
Barley price	-0.090	-0.072	-20.0
Sorghum price	-0.112	-0.080	-28.6
Soybean price	-0.005	-0.010	+100.0
		Southern Plains	
Wheat price	0.336	0.393	+17.0
Sorghum price	-0.112	-0.166	+48.2
Corn price	-0.030	-0.087	+190.0
Cotton price	-0.028	-0.073	+160.7
		North Central	
Wheat price	0.553	0.567	+2.5
Corn price	-0.133	-0.138	+3.8
Soybean price	-0.109	-0.117	+7.3
Oat price	n.a.	-0.096	n.a.
		Southeast and Delta	
Wheat price	0.216	0.267	+23.6
Sorghum price	-0.058	-0.091	+56.9
Corn price	-0.161	-0.193	+19.9
Soybean price	0.136	0.164	+20.6

n.a. = Not applicable. 1/ Estimates obtained by FAPRI (Adams). 2/ Estimates obtained from this study.

Factors Contributing to the Decline in 1999 Winter Wheat Acreage

Winter wheat seeded area for 1999 is estimated by USDA to total 43.4 million acres—the smallest since 1972 and down 7 percent from the 46.4 million for 1998 (USDA, 1999). How does the National Agricultural Statistics Service (NASS) estimate compare with results from this study? What are the key factors that have contributed to the acreage decline?

The most significant factor contributing to the decline in 1999 winter wheat seedings is the lower wheat price expected by producers, especially for SRW wheat. Based on July 1999 new-crop futures prices at Kansas City in mid-October 1998, the expected harvesttime farm price for 1999-crop HRW wheat was estimated to decline 13.6 percent from last year. The expected price for SRW wheat based on July 1999 new-crop futures at Chicago was projected to decline even more—19.6 percent. Thus, the expected price for winter wheat was estimated to decline 15.4 percent. Given the own-price elasticity of 0.383 for winter wheat plantings, the decline in the expected wheat price implies a decline of about 6 percent in winter wheat seedings from 1998, or about 2.75 million acres.[11]

The decline in the expected price of competing crops would only partly offset the effect on winter wheat seedings due to the decline in the expected price for winter wheat itself. For winter wheat producers, the declines in expected prices for competing crops based on new-crop futures prices in mid-October 1998 were 8 percent for sorghum and corn, 6 percent for barley (corn futures prices are used as a proxy for the barley price), 13 percent for soybeans, and 2 percent for cotton.[12] The decline in the expected price of these competing crops altogether is estimated to add not more than 0.4 million acres to winter wheat seedings.

Including both own-and cross-price effects altogether, the acreage response model suggests a decline of 2.3 million acres in winter wheat acreage from last year, compared with the decline of 3.1 million acres estimated by USDA in January. Thus, this model projected winter wheat acreage to total 44.1 million acres—1.6 percent higher than the 43.4 million estimated by USDA in January. The discrepancy could be attributed to the effect on wheat plantings of excessive rainfall in early planting season followed by dryness in the South, poor weather that prevented the seeding of some HRW acres in Montana, and forecasting error of the model.

[11] The own-price elasticity for winter wheat potentially could be slightly higher than the 0.383 reported here because the effect of any price changes in other competing crops (such as sunflower, canola, and alfalfa) on winter wheat seeding is not reflected in the acreage response model due to a lack of readily available, accurate data on the costs of production for these crops in the Central and Northern Plains region.

[12] The expected prices for sorghum and barley are linked to the expected price of corn based on historical relations between sorghum and corn prices, and between barley and corn prices. As a result, the expected sorghum price is estimated to follow 100 percent the change in the expected corn price and the expected barley price follows 77.3 percent of the change in the expected corn price.

Implications for Spring Wheat Plantings

Spring wheat (including durum) plantings in 1999 were projected by USDA in late February at 19.1 million acres—a decline of 1.3 million acres from last year's planting intention, but only 0.3 million acres lower than actual 1998 plantings (Riley).[13] This projected decline from 1998 intended acreage reflects a decline in the expected price from last year not only for hard red spring (HRS) wheat but also for durum wheat. This acreage response model framework helps explain the reduction from last year's planting intentions.

As of March 15, 1999, the September futures price for HRS at the Minneapolis Grain Exchange was settled for $3.560 per bushel—down 2.6 percent (in farm price equivalent) from the September futures price in May 1998. This price decline implies a 0.8-percent decrease in HRS wheat acreage (about 0.13 million acres) based on the 0.291 own-price elasticity. The small decline in this year's new-crop futures price for HRS wheat is expected to keep the negative own-price effect on HRS wheat plantings at a minimum.

The decline in the expected price for competing crops (such as barley, corn, and soybeans) would partly offset the effect on spring wheat plantings due to the decline in the expected price for spring wheat itself, but the offsetting effect would likely be relatively small. Thus, including both own-and cross-price effects altogether based on market conditions as of March 15, 1999, the acreage response model suggests a slight decline in this year's spring wheat planting intentions from last year.

Conclusions

The own-price acreage elasticity for U.S. wheat is estimated at 0.36 based on the acreage response model developed in this study. Winter wheat own-price elasticity (0.383) is higher than spring wheat (0.291) because a larger number of competing crops and a wider geographic distribution apply more readily to winter wheat than to spring wheat. Incorporating the cross-price effect of minor oilseeds (such as sunflower and canola) in the acreage response model potentially could show a greater response to changes in own price.

In addition, the cross-price effect of changes in corn and soybean prices on winter wheat plantings appears to be understated in light of experience since 1996. Perhaps the record high prices for soybeans, corn, and wheat in 1996 might have skewed the model results. Corn and soybeans were important competing crops for winter wheat in Kansas and South Dakota. Also, there was a huge jump in spring wheat acres in 1996 in response to the record high prices in the spring, and there have been large increases in corn, soybeans, and minor oilseed plantings over the last 3 years.

The use of NFA data also restricts the model from capturing more fully the cross-price effect of changes in the spring wheat price on winter wheat plantings in many areas of the Northern Plains. The acreage response is estimated for all wheat by region because no separate NFA data for winter and spring wheat were readily available. This data limitation precludes us from obtaining the cross-price effect from changes in the spring wheat price on winter wheat plantings.

The 7-percent decline in winter wheat seedings for 1999 is attributed primarily to a 15-percent decline in the expected price for winter wheat. The own-price effect itself implies a decline of 2.75 million acres or more in winter wheat seedings. Spring wheat plantings in 1999 were projected by USDA in late February to decline to 19.1 million acres. A decline in the expected prices—3 percent for "other spring" and 22 percent for durum—is the main contributing factor.

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[13] Actual plantings of spring wheat last year fell short of planting intentions by 1.0 million acres because of rising oilseed prices between early March and late May 1998, which induced producers to switch from spring wheat to oilseeds.